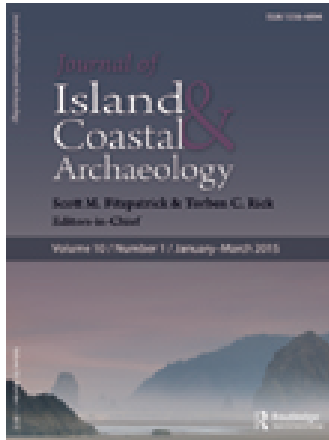


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The Journal of Island and Coastal Archaeology

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Early Archaic Fishing (12,600-9,200 cal yr BP) in the Semiarid North Coast of Chile

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Published online: 12 Jan 2015.

To cite this article: Philippe Béarez, Donald Jackson & Noémy Mollaret (2015) Early Archaic Fishing (12,600-9,200 cal yr BP) in the Semiarid North Coast of Chile, *The Journal of Island and Coastal Archaeology*, 10:1, 133-148, DOI: [10.1080/15564894.2014.940096](https://doi.org/10.1080/15564894.2014.940096)

To link to this article: <http://dx.doi.org/10.1080/15564894.2014.940096>

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Early Archaic Fishing (12,600–9,200 cal yr BP) in the Semiarid North Coast of Chile

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ABSTRACT

We present the results of the analysis of fish remains from an archaeological context (Punta Ñagué) associated with the earliest settlers in the semiarid northern coast of Chile and dated to the end of the Pleistocene (12,916–11,043 cal yr BP). The great majority of the species identified are fish that can be captured with nets in the nearshore subtidal and inter-tidal zones. These results, along with evidence from other early archaeological sites in northern Chile, demonstrate the early systematic exploitation of fish species, particularly Sciaenidae. These fish constituted an abundant and reliable resource, which contributed significantly to the subsistence of these early maritime-adapted settlers who populated the Pacific coast of South America.

Keywords coastal migration route, marine resources, maritime adaptation, Terminal Pleistocene, Western South America

INTRODUCTION

The hypothesis that the earliest settlers of the Americas followed a coastal route (Dixon 2001; Erlandson et al. 2007; Fladmark 1979; Surovell 2003) is increasingly gaining sup-

port from the existence of early archaeological sites along the Pacific Coast of North America (Des Lauriers 2006; Erlandson et al. 2011; Jones et al. 2002) to South America (DeFrance et al. 2001; Dillehay et al. 2012; Jackson et al. 2011; Lavallée and Julien

Received 1 April 2014; accepted 23 June 2014.

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2012; Sandweiss et al. 1998; Stothert 1988; Stothert and Quilter 1991). In this context, the first coastal adaptations in northern Chile are known as the “Huentelauquén Cultural Complex”, identified from numerous archaeological sites spread along the arid coast (24° S) to the southern extreme of the semiarid coast (31° S). Several of these sites are dated to the beginning of the late Pleistocene and Early Holocene, between about 13,000 and 9,000 years ago (Jackson et al. 2011; Jackson and Méndez 2005; Llagostera 1977, 1979; Llagostera et al. 2000).

These archaeological sites, usually shell middens, represent camps with areas associated with mollusc processing and food consumption, and areas destined for the processing, use, and discarding of lithic tools (Jackson et al. 1999). The stratigraphy provides evidence of the exploitation of primarily marine resources, including molluscs, crustaceans, echinoderms, fish, and marine mammals, as well as birds and a few species of terrestrial mammals (camelids, carnivores, and rodents). The lithic technology associated with these sites includes bifacial projectiles, knives, scrapers, sharpeners, and, occasionally, grinding tools, among other elements, such as some unique geometric stone objects also known as cogged stones (Jackson et al. 1999; Llagostera 1979; Weisner et al. 2000).

This Huentelauquén Cultural Complex on the semiarid northern coast of Chile might represent two, possibly diachronic, main types of settlement patterns. The first one corresponds to a central base-dispersed pattern along the coast, with a strong emphasis on the procurement of marine resources; whereas the second, a possibly more recent pattern, is focused on small inland valleys (*quebradas*), with emphasis on hunting and gathering (Jackson and Méndez 2005), with eventual movements towards valleys and mountain environments (Galarce 2004; Jackson 1998).

A significant form of evidence that lends support to the theory that these early settlements represent coastal adaptations is the existence of a diverse and abundant ichthyofauna. While no human population has depended exclusively on fish, just as fish ex-

ploitation is not the only indicator of aquatic adaptations, their presence is highly significant. Fish are mobile species with varied habits, which requires fishers to have specific ethological and technical knowledge in order to capture them. Thus, the exploitation of a diverse and abundant ichthyofauna implies that fishers had a deeply rooted coastal knowledge base. Furthermore, fish appear to be the principal source of proteins and fatty acids, which, along with other resources, provided a reliable sustenance for these coastal populations.

In this article, we present the results of the study of fish remains recovered at Punta Ñagué (LV 098A), a Late Pleistocene/Early Holocene coastal site in the semiarid region of northern Chile (Jackson et al. 2011; Jackson et al. 1999). The set of taxonomic information, the quantitative analysis (size and weight) of the fish remains, along with context data allowed us to identify the species represented in the midden, their form of capture, and their relative contribution to the diet of the Huentelauquén groups that inhabited the site of Punta Ñagué. These results are compared with the analysis of the ichthyofauna of two other Early Holocene sites in northern Chile: La Chimba 13 (Llagostera 1979; Llagostera et al. 1997) and Huentelauquén (Weisner et al. 2000).

STUDY AREA AND ARCHAEOLOGICAL CONTEXT

The study area is located in the semiarid coast of Chile (31° S), in the transitional zone between the dry region in the north and the Mediterranean-climate region in central Chile, characterized by dry summers and low winter rainfall due to the quasi-permanent presence of the South Pacific Subtropical Anticyclone (Van Husen 1967). This zone is highly susceptible to the annual variations associated with the phenomenon of El Niño Southern Oscillation (ENSO). During El Niño events, the winter weather conditions are exceptionally warm and wet in central Chile, while during La Niña phase, abnormally cold

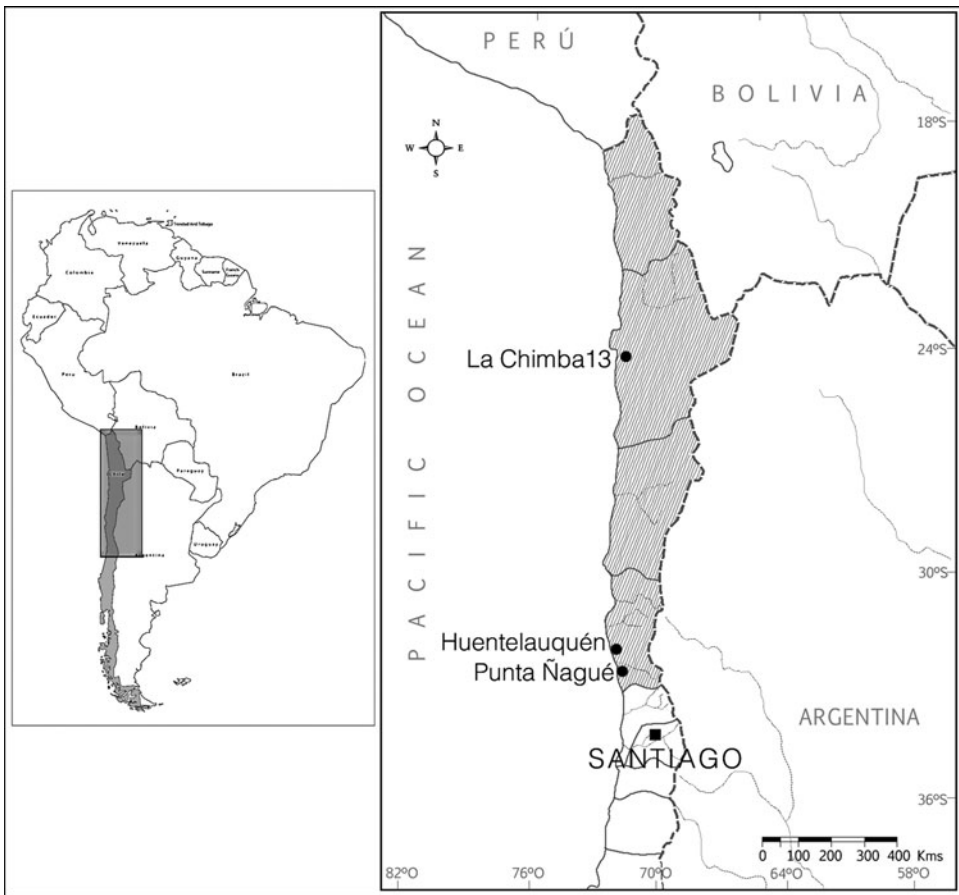


Figure 1. Map of the study area showing the early archaeological sites of the north coast of Chile: Punta Ñagué (LV 098A), Huentelauquén, and La Chimba 13.

and dry conditions prevail in this same region (Accituno 1988).

Pollen records from the coast of Los Vilos indicate the spread of swampy forest taxa ca. 13,300 cal BP, which suggests that cold and wet conditions prevailed during this time (Villagrán and Varela 1990). Towards the beginning of the Early Holocene, an abrupt change is attested by a decline in marsh and aquatic species, as well as a decline in the richness of semiarid scrubland in the region (Villagrán and Varela 1990). These results are consistent with the data obtained from Quebrada Santa Julia, which indicate a drier climate than today between ca. 11,200 and

10,500 cal BP, followed by a wetter period attested by the dominance of coastal shrubs and the spread of swampy habitat between ca. 10,500 and 9,500 cal BP (Maldonado et al. 2010). An increase in herbaceous and shrub taxa after ca. 9,500 cal BP indicates a return to drier conditions, consistent with the process of widespread regional aridification during the Early to Middle Holocene (Maldonado and Villagrán 2006).

Otoliths from the site of La Chimba 13 (previously known as Quebrada Las Conchas), located in the northern arid region of Chile (23° S), provide evidence of limited variations in the oceanographic



Figure 2. Coastal environment at Punta Ñagué and location of the archaeological site (LV 098A): view from the South.

conditions during the Early Holocene, although the presence of *Micropogonias altipinnis* indicates the flow of warm waters from the north into the region during the stated period (Llagostera 1979; Llagostera et al. 1997).

Within this context, the settlement of Punta Ñagué (LV 098A) is found on the coast of the province of Choapa, in the southern extreme of the northern semiarid region of Chile (Figure 1). It is located on a small peninsula that is part of a marine terrace (25 m.a.s.l.), covered with the deposits of partially shifting paleodune systems. The eastern shore adjacent to the settlement is a protected bay with a series of sandy beaches, while the southwest side is an exposed rocky shore with rich marine biodiversity (Figure 2).

Today the site is located adjacent to the coastline on a high marine terrace, but at the time of the first human occupation the sea was about 10 km off the current coastline (Ortega et al. 2012). Despite changes in post-glacial sea levels, the site was never submerged. This condition made the site accessible in the past and allowed the preservation of the site today (Jackson et al. 2011).

Close to the site (~500 m) there is a permanent source of drinking water that was probably available when the settlement of Punta Ñagué was occupied. The site is situated among deposits of paleodunes in a longitudinal depression (100 × 40 m). Two distinct areas can be distinguished: a zone for processing, using, and discarding lithic tools; and another area containing numerous shell mounds where domestic activities took place, next to several hearths associated with lithic tools (including projectile points, knives, scrapers, sharpeners, and grinding stone), waste from processing and reuse, as well as preforms of geometric stone objects, micro-mortars, engraved plates and necklace beads. The raw materials used for the lithic artifacts are of local origin.

The shell mounds are composed of a great variety of mollusc species (gastropods and bivalves), as well as some crustaceans and echinoderms. The vertebrate fauna includes marine mammals (*Otaria flavescens*, *Arctocephalus australis*, and *Lontra felina*), which for the most part arrived complete at the site, especially the juvenile specimens (Hernández 2007). In addition to the fish remains that are the focus of this study,

it was also possible to record several bird species (*Spheniscus* sp., *Phalacrocorax* sp., *Pelecanus thagus*), five rodent species, two of which were eaten (*Octodon* sp. and *Abrocoma bennetti*) as their remains were associated with a hearth, and a few remains of guanaco (*Lama guanicoe*) and fox (*Lycalopex* sp.).

The stratigraphy shows that the archaeological deposits consist of molluscs and other cultural remains within a sandy matrix with a uniform color and grain size. Three cultural sequences were identified. The first one is a lower sequence, 10 cm thick, consisting of a discontinuous shell midden with few associated artifacts and dominated by the gastropod *Concholepas concholepas*. A thin sterile layer separates the middle sequence from the lower one. The second sequence identified, the middle sequence, is 30 cm thick, and was composed of several shell mounds of mostly *Mesodesma donacium*, associated with hearths, abundant marine faunal remains and traces of the processing, use, and discarding of artifacts. Finally, the upper cultural sequence, 35 cm thick, included an extensive shell midden consisting mainly of *C. concholepas*, associated with vertebrate remains and lithic tools. In all the cultural sequences we recorded evidence of hearths adjacent to the shell mounds that were the focus of the main domestic activities, such as food consumption and tool making.

Six radiocarbon dates (Table 1) place the identified cultural sequences in chronological order. Two ^{14}C dates are on charcoal, while the remaining samples were dated on shells of marine molluscs. For shells, the dates were calibrated considering a correction for the marine reservoir effect, estimated in 911 ± 278 years [$R + \Delta R = 400 + (511 \pm 278)$] for the Early Holocene at these latitudes (Ortlieb et al. 2011). All the dates can be placed around the Pleistocene-Holocene transition and the Early Holocene.

Only the lower and middle cultural sequences can be positively attributed to the Huentelauquén Cultural Complex, while the upper sequence can be attributed to another cultural phase regionally known as the Papudo Cultural Complex (Méndez and Jackson 2006). Other settlements of the Huentelauquén Cultural Complex on the coast of Choapa, corresponding to residential camps and work camps (Jackson and Méndez 2005; Llagostera et al. 2000), are probably related to the lower and middle cultural sequences at Punta Ñagué, forming part of the same settlement system along the semiarid north coast of Chile.

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MATERIALS AND METHODS

The faunal remains were recovered at Punta Ñagué (LV 098A) during excavations carried out between 1996 and 2004. The excavations covered a total area of 61 m² with an estimated volume of 16.4 m³ (Table 2). The faunal remains were sorted, and only fish remains have been studied in detail at this stage. Fish remains recovered from the upper cultural sequence were excluded from the present analysis because they were scarce (NISP = 73), which does not seem to be related to differential preservation. Fish remains consisted of bones, mainly vertebrae, and otoliths (Figure 3). The general preservation was poor; however, a significant number of remains were sufficiently well-preserved for proper taxonomic identification.

Excavations were carried out in 2 × 2 m units, following the natural stratigraphy and further separated into artificial levels. All sediments were sieved through 4 mm mesh screens to recover all cultural remains. Additionally, two soil samples (3 L) were extracted from each square meter and level: one was sieved through a fine mesh screen (2 mm), and the other was used for flotation. In addition to the recovery of organic remains (charcoal and seeds), this procedure allowed us to evaluate the loss of fish remains from the use of wide mesh screens (4 mm). The results indicate only a minor loss of ichthyoarchaeological material but higher rates of fragmentation (Didier 2000).

The locations of features, artifacts, and other remains were recorded during the excavation in order to create distribution plans. Profile drawings recorded the stratigraphy of the excavation units, allowing us to

Table 1. Radiocarbon dates from Punta Ñagué (LV 098A).

Cultural sequence	¹⁴C, yr BP	Cal yr BP (2 sigma)	Cal yr BP (Res. effect, 2 sigma)	Sample	Lab. N°	Reference
Lower	11,100 ± 80	/	12,630–11094	Marine shell	NSRL - 11082	Jackson and Méndez 2005
Lower	10,600 ± 70	/	12,038–10,341	Marine shell	Beta - 106802	Jackson and Méndez 2005
Lower	10,550 ± 50	12,664–12,040	/	Charcoal	OS - 68056	This article
Middle	10,120 ± 80	/	11,180–9,708	Marine shell	Beta - 55279	Jackson and Méndez 2005
Middle	9,730 ± 60	/	10,627–9,258	Marine shell	Beta - 94101	Jackson and Méndez 2005
Middle	9,160 ± 40	10,491–10,183	/	Charcoal	Beta - 341872	This article

Table 2. Excavated area and volume by cultural sequence at Punta Ñagué (LV 098A).

Cultural sequence	Excavated area	Estimated volume
Upper	9 m ²	4.4 m ³
Middle	32 m ²	86 m ³
Lower	20 m ²	3.4 m ³
Total	61 m ²	16.4 m ³

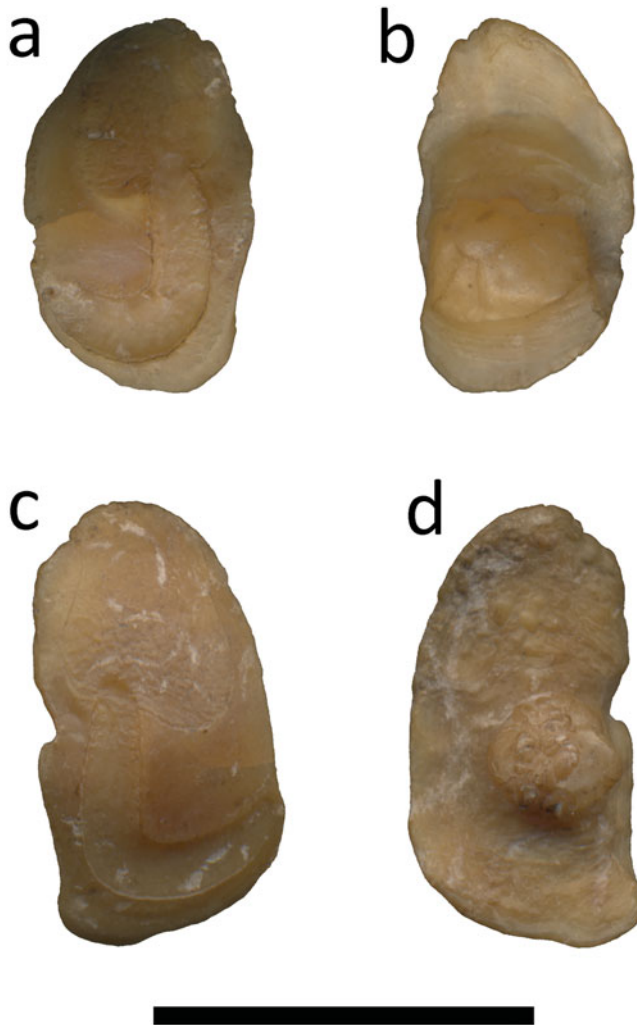


Figure 3. Otoliths of the main sciaenid species identified at Punta Ñagué (LV 098A): a-b *Sciaena deliciosa*; c-d *Cilus gilberti*. Scale bar: 1 cm.

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define the distinct cultural sequences of the site more clearly.

Fish remains were identified to the most precise taxonomic level possible (genus or species level) based on direct comparison with skeletons from the reference collection housed at the Muséum national d'histoire naturelle (Paris, France). Specimens of all taxa were counted and weighed to 0.01 g. Basic quantification of taxa was calculated as Number of Identified Specimens (NISP) and specimen weight. The Minimum Number of Individuals (MNI) was estimated based on laterality and size for paired specimens or by dividing the NISP by the number of possible specimens per individual in the case of unpaired specimens (vertebrae, for example). The original live size and weight of the fish were estimated by direct comparison with reference skeletons or using allometric regression formulae applied to otoliths (Béarez 2000). The relationship between body weight or length and specimen weight or length is best described by a power equation, taking into account allometric growth (Huxley and Teissier 1936):

$$Y = aX^b.$$

The maximal length and height of each sagitta (saccular otolith) were measured with a digital caliper to 0.01 mm, following Schwarzhans (1993). The weight was also measured to the nearest 0.01 g. Then the regression formulae established by Béarez (2012) was applied to the two main sciaenids identified among the fish remains: *Sciaena deliciosa* (Tschudi 1846) and *Cilus gilberti* (Abbott 1899). The adopted method is a two-step method (see Casteel 1976). Otolith height was chosen for measurement because it is the dimension most frequently preserved when sagittae are broken. The equations are the following:

$$TL_{sd} = 18.989 \times OH^{1.5584},$$

$$W_{sd} = 0.0000099899 \times TL^{3.0243},$$

$$TL_{cg} = 12.292 \times OH^{1.8128},$$

$$W_{cg} = 0.000013761 \times TL^{2.9651},$$

where TL is total length of fish, OH is otolith height, and W is live weight of fish. Species name abbreviations are *sd* for *S. deliciosa* and *cg* for *C. gilberti*. Measurement units are millimeters and grams.

Radiocarbon dates were calibrated to 2 sigmas with Oxcal 4.2 (Bronk Ramsey 2009) with the curve ShCal13 (Hogg et al. 2013) and expressed in calibrated years before present (cal BP). The marine reservoir effect was estimated in 911 ± 278 years [$R + \Delta R = 400 + (511 \pm 278)$] following Ortlieb et al. (2011), and this correction was used for all marine dates.

RESULTS

A total of 9265 fish bones, weighing 782.7 g, were examined (Table 3). Of these, 4092 (532 g) could be identified, with a large majority taken to species level (91% of NISP). In spite of the abundance of vertebrae, which are often more difficult to identify, and the rather poor conservation of the bony elements, this gives a good identification ratio of 44% by NISP, and 68% by weight. The otoliths are well represented and preserved (Figure 3), with a total of 329, mostly from sciaenids (95%). Two sets of otoliths could be used for size reconstruction: 112 for *Sciaena deliciosa* and 197 for *Cilus gilberti*.

Almost all of the identified taxa are bony fish (Teleostei) belonging to 16 families, 16 genera, and at least 23 species (Table 3). Four families represent 83% of the NISP, i.e., Sciaenidae (drums) with 30% (60.7% of bone weight), Clupeidae (menhadens) with 21%, Haemulidae (grunts) with 20%, and Aplo-dactylidae (marblefishes) with 12%. Cartilaginous fishes (Chondrichthyes) are almost entirely absent, being represented by only two vertebrae from an angel shark (*Squatina armata*).

The variety of identified species includes fish from sandy habitats and especially from rocky shores. The mullet (*Mugil* sp.) occurs in coastal or estuary environments, which existed near the shores of Punta Ñagué. Two species of sciaenids are represented:

Table 3. Fish remains identified from different cultural sequences at Punta Ñagué (LV 098A): NISP, weight in grams, MNI, and respective percentages.

Family	Species	Lower sequence					Middle sequence						
		NISP	%	Weight	%	MNI	%	NISP	%	Weight	%	MNI	
Sciaenidae	<i>Sciaena delicatosa</i>	136	22.6	24.26	37.4	31	15.8	726	20.8	154.55	33.1	168	19.6
Clupeidae	<i>Ethmidium maculatum</i>	126	21.0	4.18	6.4	25	12.8	699	20.0	23.88	5.1	86	10.1
Haemulidae	<i>Isacia conceptionis</i>	130	21.6	3.51	5.4	27	13.8	681	19.5	20.26	4.3	92	10.8
Aplodactylidae	<i>Aplodactylus punctatus</i>	48	8.0	3.14	4.8	20	10.2	424	12.1	32.09	6.9	88	10.3
Sciaenidae	<i>Cilus gilberti</i>	46	7.7	15.02	23.2	30	15.3	321	9.2	129.08	27.6	154	18.0
Pinguipedidae	<i>Pinguipes chilensis</i>	21	3.5	3.53	5.4	14	7.1	151	4.3	24.62	5.3	78	9.1
Cheilodactylidae	<i>Cheilodactylus variegatus</i>	18	3.0	2.54	3.9	9	4.6	122	3.5	17.9	3.8	53	6.2
Bleenniidae	<i>Scartichthys</i> spp.	31	5.2	0.61	0.9	11	5.6	100	2.9	1.79	0.4	19	2.2
Mugilidae	<i>Mugil</i> spp.	18	3.0	2.99	4.6	8	4.1	92	2.6	18.82	4.0	36	4.2
Carangidae	<i>Trachurus murphyi</i>	3	0.5	0.99	1.5	3	1.5	52	1.5	26.72	5.7	26	3.0
Clupeidae	<i>Sardinops sagax</i>	4	0.7	0.15	0.2	1	0.5	47	1.3	1.9	0.4	3	0.4
Pomacentridae	<i>Chromis</i> spp.	3	0.5	0.09	0.1	3	1.5	27	0.8	0.69	0.1	16	1.9
Kyphosidae	<i>Graus nigra</i>	3	0.5	2.05	3.2	3	1.5	16	0.5	11.53	2.5	12	1.4
Labrisomidae	<i>Labrisomus</i> spp.	3	0.5	0.45	0.7	3	1.5	8	0.2	0.62	0.1	6	0.7
Kyphosidae	<i>Girella laevisfrons</i>	2	0.3	0.13	0.2	2	1.0	5	0.1	0.54	0.1	3	0.4
Pinguipedidae	<i>Prolatilus jugularis</i>	1	0.2	0.08	0.1	1	0.5	6	0.2	0.27	0.1	5	0.6
Labrisomidae	<i>Auchenionchus</i> spp.	2	0.3	0.17	0.3	2	1.0	4	0.1	0.41	0.1	2	0.2
Gobiesocidae	<i>Sicyases sanguineus</i>	4	0.7	0.42	0.6	2	1.0	1	0.0	0.02	0.0	1	0.1
Scombridae	<i>Sarda chilensis</i>							4	0.1	1.13	0.2	3	0.4
Kyphosidae	<i>Medialuna ancietae</i>							2	0.1	0.09	0.0	2	0.2
Labridae	<i>Semicossyphus darwini</i>	2	0.3	0.52	0.8	1	0.5						
Squatinae	<i>Squatina armata</i>							2	0.1	0.24	0.1	1	0.1
Pomacentridae	<i>Nexilosus latifrons</i>							1	0.0	0.02	0.0	1	0.1
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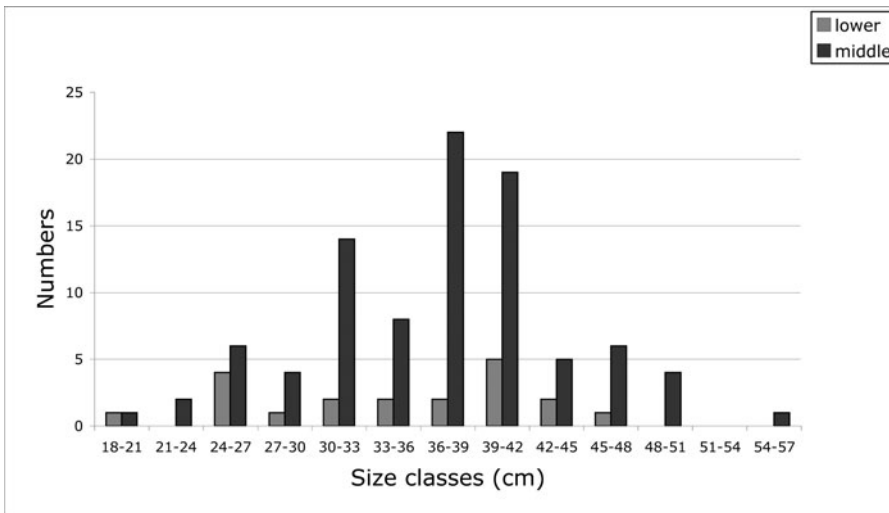


Figure 4. Size distribution of canque, *Sciaena deliciosa*, in both sequences at Punta Ñagué (LV 098A).

the canque (*Sciaena deliciosa*) and the corvina (*Cilus gilberti*). The former is a medium-sized (up to 50–55 cm total length) predatory fish, which lives over sandy bottoms, often close to the beach, where it feeds on crustaceans and smaller fish. The

latter is a large-sized (up to 115–120 cm TL) predatory fish, which moves along the seashore in schools, usually feeding on small coastal pelagic fishes like anchovies or small sardines, but also on crustaceans (*muy-muy*, *Emerita analoga*).

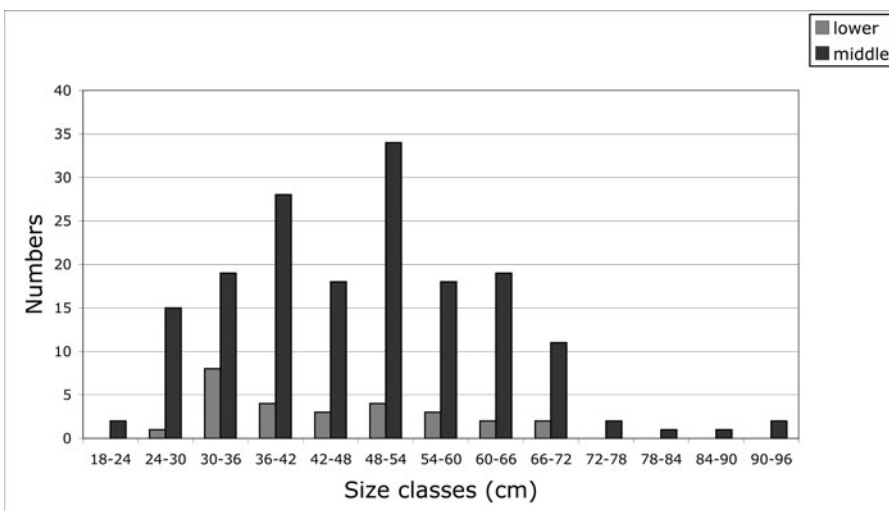


Figure 5. Size distribution of corvina, *Cilus gilberti*, in both sequences at Punta Ñagué (LV 098A).

Table 4. Density of fish remains by cultural sequence at Punta Ñagué (LV 098A).

Sequence	NISP/m ³	W/m ³	MNI/m ³
Middle	406	54.3 g	100
Lower	177	19.1 g	58

The clupeids are mainly represented by pacific menhadens (*Ethmidium maculatum*), accompanied by a few sardines (*Sardinops sagax*). Both species are small pelagic coastal fishes, which live in large schools. The haemulids are exclusively represented by the cabinza grunt (*Isacia conceptionis*), a small (usually 32 cm TL) benthopelagic coastal fish. Aplodactylids are represented by the *jerguilla* (*Aplodactylus punctatus*), an herbivorous fish that inhabits kelp beds.

The reconstructed size for the biggest species, *S. deliciosa* and *C. gilberti* (Figures 4 and 5), indicates that specimens of medium size and larger were targeted. In the early phase, the size range for the *canque* is 20–47 cm TL (90–1180 g) with a mean of 34.5 cm TL (ca. 470 g). The size range for the *corvina* is 25–70 cm TL (180–3750 g) with a mean of 44 cm TL (ca. 1000 g). During the middle phase, the size range for the *canque* is 18–56 cm TL (70–2030 g) with a mean of 37 cm TL (ca. 600 g). The size range for the *corvina* is 21–92 cm TL (105–8500 g) with a mean of 48 cm TL (ca. 1200 g). The smallest sizes caught are similar in both species, but this is not the case for the biggest sizes, since the *corvina* grows much more than the *canque*. The most common size classes for *canque* are 36–39 and 39–42 cm TL, which corresponds to the second most abundant class for the *corvina*. Large specimens of *corvina* are rare, but it is worth noting the presence of an exceptionally large *canque* measuring 56 cm and weighing 2 kg, a size that is almost impossible to find today.

DISCUSSION AND CONCLUSION

The ichthyofauna retrieved from the archaeological material of Punta Ñagué site

is in conformity with that currently occurring in Central and Northern Chile (Boré et al. 1988; Medina et al. 2004; Pequeño 1989), and, more generally, with the fauna of the Warm Temperate Southeastern Pacific province (Spalding et al. 2007). The low frequency of sardine compared to menhaden, and the absence of Peruvian grunt (*Anisotremus scapularis*), are good indicators of cool waters. These data indicate that at the time of the occupation of the archaeological site the maritime environment was similar to today's, contrary to what was found at other Chilean sites located to the north (see Llagostera et al. 1997). However, the proportions of sciaenids (*S. deliciosa* and *C. gilberti*) are much larger in the archaeological material than in the modern small-scale fisheries in the area. This difference could reflect the effects of the overexploitation undergone by these two species over the years.

The great fish food richness is most likely from the result of the exploitation of varied environments with a variety of fishing techniques. This is confirmed by the presence of fishes inhabiting different biotopes (sandy bottoms, kelp bed rocky bottoms, pelagic nearshore waters). It is worth mentioning the rather high proportion of rocky fishes like aplodactylids, pinguipedids, and cheilodactylids, which are not common in other Chilean archaeological sites (see Llagostera et al. 1997). Moreover, the diachronic evolution of the proportions of these three groups of fish (Table 3) shows a tendency toward pelagic species, with a concurrent decline in other types of fish. This shift seems concomitant with an increase in the densities of remains (Table 4), which could indicate an increase in population density at the site, and the need for an easily available and abundant resource. The pelagic fish considered here are not larger than others, but they form schools and hence can be caught in

large quantities more easily. Hence, it could be that fishers developed or favored fishing techniques capable of obtaining a greater quantity of fish simultaneously. Also, the size range and the average size of the sciaenids increased with time. These patterns could reflect a better adaptation to sea fishing with the development of improved strategies for the exploitation of marine resources.

The lower and middle cultural sequences contain the most abundant and diverse assemblages of species. The lower sequence includes 196 specimens, and the middle sequence 855 specimens. A comparison of the two sequences shows a pattern of increasing numbers of pelagic species found on sandy shores, such as *corvinas*, with a concurrent decline in other species, as well as an increasing density of specimens per m² (Tables 3 and 4) from the lower to the middle sequence. Also evident at other early sites from northern Chile (Cervellino et al. 2000; Llagostera et al. 1997; Weisner et al. 2000), these patterns indicate a substantial rise in fishing activities towards the end of the Early Holocene.

Based on the eco-ethological characteristics of the identified species, and on the fishing techniques used today, it is likely that Punta Ñagué people used at least three different techniques. The blennies of the genus *Scartichthys*, which live on the rocky bottom shallow waters, are often wedged in the intertidal pools, and can be caught by fishing on foot at low tide. In the same way, *Sicyases sanguineus* that lives on exposed, wave-beaten rocky shores is caught from the intertidal or supralittoral zone. Small pelagic species, such as clupeids, are generally caught with nets, which makes us believe that the inhabitants of Punta Ñagué were able to manufacture nets. Stone weights found at the site were likely used for net fishing and provide further evidence of this fishing practice. Other pelagic fishes, such as horse mackerel (*Trachurus murphyi*), can be caught with net or hook and line. Sandy shore fishes like drums (*S. deliciosa*) easily take a baited hook but can also fall into a net. The fact that the most abundant size classes for both sciaenids coincide might indicate that they were fished in the same way be-

cause the size range of the fish caught by gillnet or hook is mainly influenced by the mesh or hook size (Hamley 1975). Rocky shore and kelp bed fishes, such as marblefish (*A. punctatus*), rollizo (*P. chilensis*), or morwong (*C. variegatus*), are more easily caught with hooks. Most of these fishes approach the shore close enough to be caught from the beach, by entering the water on foot. Small pelagic species are also known to wash up on the shores at some times of the year, usually in summer, when they are pursued by horse mackerels and other predators (Delfín 1901). Nevertheless, we can suppose that the inhabitants of this site made use of small boats in order to facilitate their fishing and to be able to do it more regularly.

It is likely that the main fishing technique during the occupation of the site was the use of gill nets or beach seines as used today in the intertidal or sublittoral zone adjacent to the site. After capture, the fish were taken whole to the site where they were cooked and eaten, as is attested by various elements found in association with hearths and with signs of burning.

The archaeological site of Huentelauquén is another early site (ca. 9,400–8,000 BP) located 15 km north of Punta Ñagué, close to the mouth of the river Choapa on the southern coast of the semi-arid region. It is a large deposit with habitad areas mixed along with numerous shell middens, in which at least 13 fish species were identified (Weisner et al. 2000). Similar to Punta Ñagué, these species came from rocky (e.g., *Aplodactylus punctatus*, *Auchenionchus* sp.) or sandy habitats (e.g., *Cilus gilberti*, *Mugil cephalus*). This shared pattern of faunal exploitation (although *Sciaena deliciosa* was not identified at Huentelauquén) is not shared by another site in the northern arid region, La Chimba 13 (ca. 10,000–9,000 BP). This shell midden with a high sandy component is located just north of Antofagasta in a small canyon at about 3 km from the coast line (Llagostera 1979). Among the fish remains, 17 species were recorded, most of which occur in both cultural sequences represented at the site (Llagostera et al. 1997). The most commonly exploited species, based only on

otoliths, include *Anisotremus scapularis*, *Cynoscion analis*, *Isacia conceptionis*, *Paralabrax humeralis*, and *Sciaena deliciosa* (Llagostera et al. 1997).

Results from bioanthropology based on stable isotope analyses also indicate that early coastal inhabitants of the semiarid north coast of Chile relied primarily on marine resources (Jackson et al. 2012).

In summary, the fish that dominate most sites are essentially nearshore species or, rather, fish that frequent the shores, from both sandy and rocky substrates. Their proximity to the shore facilitated their capture. At La Chimba 13, the only direct evidence of fishing technology is the presence of oval stone objects with a groove around their greatest diameter, which could have been used as net weights (Llagostera et al. 1997:176). Given their small size, light weight, and limited numbers, these objects more likely represent weights for special hooks called “poteras”. Three or four sharp bone barbs are attached to these weights and used as fishing hooks to capture fish and cephalopods mainly around sandy beaches. The use of these fishing tools is well documented ethno-historically (Silva Olivares and Báhamondes Bricks 1968).

Pebbles and tabular pieces of rock no larger than a fist, with or without modifications, could have been used as net weights. These types of artifacts are found in some archaeological contexts, but they may have been frequently abandoned along the shoreline, as they are nowadays. Fishers often leave these types of net weights behind to avoid carrying them unnecessarily, as they can be easily replaced. The presence of mullet (*Mugil* sp.) at La Chimba 13 and Huentelauquén, as well as Punta Ñagué, also suggests the use of nets because this species is difficult to capture using other techniques. Harpoons can also be used to catch flounder (*Paralichthys adspersus*) in sandy substrates. In the case of the clingfish (*Sicyases sanguineus*), these could have been caught with long sticks with a hook on the end, a technique currently used by fishers along the coast of northern Chile and southern Peru (Béarez 2012). Lanceolate points with peduncle (barbed points) that, rather than be

used for fishing, were used to hunt sea lions (Otariidae) are also known.

Even though we do not have direct evidence of the use of boats, we can assume, at the least, that boats were used to access the surf zone, as is attested by early evidence from other parts of the Pacific coast of the Americas (Béarez 2012; Erlandson et al. 2011).

Ichthyoarchaeological evidence from Punta Ñagué, as well as from La Chimba 13 (Llagostera et al. 1997), El Obispo 1 (Cervellino et al. 2000), and Huentelauquén (Weisner et al. 2000) among other early sites from northern Chile, demonstrate that the principal subsistence activities practiced at these settlements were focused on the coast, such as the exploitation of easily accessible marine resources (molluscs, crustaceans, echinoderms, and marine mammals), but especially the capture of a rich array of fish species. Among these, sciaenids (*canques* and *corvinas*) are particularly numerous and could have been captured in large volumes with gill nets or beach seines.

As a result, fish constitute the major source of subsistence for these early populations, providing enough biomass and calories. Without doubt, the harvesting of other marine resources (molluscs, crustaceans, and echinoderms) along with the exploitation of marine mammals, which are also found in the settlements, contributed to a reliable, predictable, and abundant sustenance for the earliest populations that settled along the northern coast of Chile.

Evidence from early settlements along the coast of South America, such as Las Vegas culture in Ecuador (Stoher 1988, 2011), and Quebrada Jaguay (Sandweiss et al. 1998) and Quebrada Los Burros (Lavallée and Julien 2012) in Peru, indicate a strong reliance on marine resources, where fish were a key resource in the subsistence of the first populations that settled on the South American coast. When placed in the context of evidence for Late Pleistocene or Early Holocene fishing in North America (e.g., Erlandson et al. 2011; Rick et al. 2001), these data demonstrate significant coastal adaptations and fishing capabilities by early peoples throughout much of the Pacific Coast of the Americas.

ACKNOWLEDGEMENTS

We give our thanks to Roxana Seguel (Centro Nacional de Conservación y Restauración, Dirección de Bibliotecas, Archivos y Museos, Santiago, Chile) for her conservation work in the field and laboratory, to Eréndira Quintana Morales for her help with the English translation, and to Antoine Zazzo for his comments on the draft.

FUNDING

This collaborative work was financed by the project FONDECYT 1140824, and the PPF Structure et évolution des écosystèmes of the MNHN. Excavations at Punta Ñagué were financed by the projects FONDECYT 1950372 and 1990699.

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